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SOME REMARKS ON THE FOSSIL FISHES OF MOUNT LEBANON, SYRIA.

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It is sometimes the good fortune of the archæologist to carry his excavations into the site of some long ago forgotten village or city, and there to unearth the relics of its former inhabitants. From these remains, perhaps scanty and broken, he essays to determine the manners and customs of the people, their religion, the grade of their civilization, the nature of their intercourse with the neighboring tribes, and perhaps to learn what ancient practices yet persisted and what new ones were coming into vogue.

To the palæontologist the earth's crust, in its breadth and thickness, is a burial ground from which he may exhume the remains of the animals and plants that once lived on its surface or in its waters. The words of Bryant, spoken of the races of men, may truthfully be applied to other living things,

> "All that tread
> The globe are but a handful to the tribes
> That slumber in its bosom."

But there are spots where the carcasses are sown thicker and have been better preserved than elsewhere; and to such places the scientific birds of prey, who seek for, and must usually be satisfied with, fragmentary bones, and imprints of skeletons, and scattered scales and teeth, are gathered together; and, fed on such booty, they have visions of the swarms of animals, fat, sapid, and comely, that once populated the earth.

The Cretaceous period is one of great interest to the palæontologist. It was a part of that long period which has been well called the Mesozoic; it was the closing third of the medieval age of the world's history. During the Cretaceous, vast advances were made in the extinction of ancient forms of life and in the introduction of the present order of things; so that, with the ushering in of the Tertiary, the world had become utterly transformed from the condition it had at the beginning of the Cretaceous.

In the present paper we are to consider the fishes of the upper Cretaceous period, especially those found in Mount Lebanon, Syria.

The fishes of the Upper Cretaceous come to us principally from four regions far removed from one another. One of these is in western Kansas, another in the south of England, a third in Westphalia, and the fourth in Syria. Our knowledge of the fish-bearing strata of Kansas is of comparatively recent date; the other beds have long been known. Davis, who has written an important paper on the fossil fishes of Mount Lebanon, tells us that they were known to Herodotus, 450 years B. C. Travellers within the six hundred years preceding the nineteenth century often expressed their astonishment at finding such perfect resemblances of fishes when the fissile rocks of that region were split open. Accurate and scientific descriptions of these remains have been presented only since the beginning of the nineteenth century. Blainville, Agassiz, Pictet, Humbert, Heckel, Davis, and A. S. Woodward have been the principal writers on the subject.

While fossil fishes seem to have been found in several localities in Syria, two have become especially famous, Sahel Alma and Hakel. The former is a village about eleven miles northeast of Beirut; Hakel is situated about twenty-three miles somewhat northeast of Beirut, and six miles from Jebeil, the ancient Byblus.

Recently a third locality has been explored. This is near a village called Hajula, situated about six miles south of Hakel. About two years ago, at the instance of Rev. D. Stuart Dodge, of New York City, this locality was visited by Alfred Ely Day, professor of geology in the Protestant Syrian College at Beirut; and this gentleman succeeded in making a large collection of fossils, especially of fishes. He collected many fishes at Hakel also; but he was not permitted to work at the classical locality, Sahel Alma. A large part of Professor Day's collection was presented by Rev. D. Stuart Dodge, in behalf of the Protestant Syrian College, to the American Museum of Natural History, in New York, and the present writer has had the opportunity of studying and describing them. An account of the interesting things in this collection, illustrated by fourteen plates, has recently been issued by the Museum (*Bull. Amer. Mus. Nat. Hist.*, Vol. 19, pp. 395–452, pls. 24–37).

From the fish-beds at Sahel Alma there have been described about sixty species of fishes; from Hakel, fifty species; and now there come from Hajula thirty-four species. Doubtless further collecting at Hajula will much increase its number. The fishes found at Sahel Alma belong, in general, to the same genera as those at Hakel and Hajula; but, of its sixty odd species, probably not one is found at the other localities. On the other hand, twenty-one species that have been secured at Hajula occur also at Hakel. These data make it quite certain that the beds at Sahel Alma are on a different level from those at Hakel and Hajula; while those at the latter places are on the same, or nearly the same, horizon. Opinions have differed as to which are older, the fish-beds at Sahel Alma or those at Hakel; but it is apparently the view of the best modern authorities that those at Hakel are more ancient. This opinion appears to be supported by the character of the fishes in each. From a study of the fishes taken at Hajula the writer has concluded that the beds containing them belong to a slightly more recent time than that of the beds at Hakel.

As to the position of the fish-bearing strata of Mount Lebanon in the geological scale, all authors now agree that they belong to the Upper Cretaceous. The epochs of this division, as recognized in Europe, are, beginning with the lowest beds, the Cenomanian, the Turonian, the Senonian, and the Danian. Some authorities have assigned the fishbeds of Mount Lebanon to the Turonian, others to the Senonian. A. S. Woodward, in the earlier pages of the first volume of his splendid work, *Catalogue of Fossil Fishes*, credits the Mount Lebanon fishes to the Turonian, but in the later pages they are said to belong to the Senonian. In the third volume they are more definitely referred to the Upper Senonian; but in the fourth volume they are cited simply as coming from the Upper Cretaceous. The deposits from which the fossil fishes of Westphalia are exhumed are regarded as Senonian. Rœmer (*Zeitschr. deutsch. geol. Gesell.* vol. 6, 1854, p. 201) assigns these beds to the older Senonian. Lepsius (*Geol. Deutschlands*, vol. 1, p. 177) and Credner (*Elem. Geol.*, p. 637) regard them as belonging to the Upper Senonian. A comparison of the genera and species of fishes from Mount Lebanon with those from Westphalia has convinced the present writer that the horizons of the two groups of beds are practically the same, and that the Mount Lebanon fishes, therefore, belong to the Upper Senonian. Hence these fishes lived near the close of Cretaceous times; and we are enabled to observe the advances which this group of animals had made during this long age.

At the beginning of the Cretaceous the shark-like animals were few, so far as the record shows, and these mostly of now extinct genera. There were doubtless species of Hexanchus (Notidanus), a decadent genus represented now by the cow sharks; for we know that species lived during the Jurassic. There was a member or two of the Heterodontidæ (Cestraciontidæ), and possibly the Lamnidæ were represented. No rays or sawfishes are known from the Lower Cretaceous, but there must have been species of Rhinobatus, since they had previously existed and the genus is yet on the earth. But with the opening of the Upper Cretaceous, in the Cenomanian, the Lamnidæ and the Scylliidæ were well established; while in the Senonian beds at Sahel Alma there were three or four species of each family. At Hakel only a single species of shark, *Otodus sulcatus*, has been found; at Hajula, no shark.

Of the rays there are interesting forms at all three of the Mount Lebanon localities. A. S. Woodward has described from Sahel Alma the rostrum of a primitive sawfish, *Sclerorhynchus atavus*, the rostral teeth of which are not in sockets and which, as they are followed backward, graduate into the shagreen scales of the side of the head. In the collection from Hajula the writer has found three new species, one represented by a considerable portion of a rostrum; another, by a complete rostrum and a considerable part of the head; and a third, by much of the rostrum, the head and most of the pectoral fins. There is likewise the trunk of a species of the genus present. These specimens show that Sclerorhynchus belongs to the Pristidæ, and further, that at that far away day the sawfishes resembled closely those of our time, except in the mode of attachment of their rostral teeth. Between that time and the Eocene, these modified shagreen scales found deeper and deeper lodgement in the cartilages of the rostrum, attained greater size, and became the efficient weapons that we find them to-day.

The new Sclerorhynchus which is represented by the rostrum alone has been called *S. sentus*, because on one flat side of the rostrum there are two rows of short spines. The species represented by the complete rostrum has been named *S. solomonis*, in recognition of the interest of the great Israelitish king in natural history (i Kings, iv, 33). The third species is to be known as *S. hiram*, in honor of the friend and ally of Solomon.

Of the genus Rhinobatus three species have already been described from Sahel Alma and one from Hakel. A new one, *R. eretes*, is found in the collection from Hajula. Likewise a new ray comes form Hajula, and this has been named *Raja whitfieldi*, in honor of Prof. R. P. Whitfield, of the American Museum. It is surprising to observe how little these rays have changed since those Senonian times.

Of the true fishes, Pisces, we find in the Mount Lebanon fish beds but few representatives of the old families of the Jurassic. None has been obtained at Sahel Alma, and this speaks for the later time of these beds. From Hakel there have been known four species of pycnodonts; and now from Hajula there is secured a new one, *Coccodus insignis*. It is represented by many specimens, some of them quite perfect; and is characterized by having a short and compressed occipital spine. It likewise presents clear evidences of pectoral and ventral fins. Hakel furnishes a new and strange fish which possibly belongs to the Belonorhynchidæ, and which has been named *Stenoprotome hamata*. The head, as it is shown on the matrix, resembles in miniature that of the African antelope, Bubalis, even to the horns. The horns, or spines, are probably connected with the operculum. The tip of each is very sharp, and just below this there is a barb, like that of a fishhook. There seem to have been no vertebræ, and the body has been covered with bony plates.

The Macrosemiidæ and Oligopleuridæ, scantily represented at Hakel, have not yet been found at either Sahel Alma or Hajula. Some of the fishes of the Upper Cretaceous had already acquired many of the characters which are found in our modern forms. In the majority of them the skeleton was extensively ossified, the vertebræ were as we find them to-day, the fins had lost their fulcra, and in many cases the rays had become spinous. A number of the families that still persist had already come into existence, and this is true of a few genera. The Elopidæ, best known by the tarpon of our southern waters, are recognized in eight species at Sahel Alma, three at Hakel, and one at Hajula. None of the species begins to attain the size of the tarpon. The Ichthyodectidæ, a family close to the Chirocentridæ, is thought to be represented at Hakel and Hajula by a species which Woodward calls *Ichthyodectes libanicus*, but which the present writer refers to a new genus, Eubiodectes, that is, a biter that gets a good living. It grew to a size somewhat greater than that of the shad.

Ctenothrissa is a genus which stands as the type of the Ctenothrissidæ. It possessed many of the structures that are greatly in vogue in our own day among the denizens of the deep. It had serrated scales, and the ventral fins had been moved forward to a position just below the pectorals. The writer has described a new and beautiful species, *Ctenothrissa signifer*, from Hajula. It is characterized by the possession of very high dorsal and anal fins; and the ventral rays likewise were greatly elongated.

The Clupeidæ, so abounding in genera and species in the salt and fresh waters of our time, were present in force during the Senonian; but only one of the genera of that time has survived. Two species of Scombroclupea were exceedingly abundant at both Hakel and Hajula. The specimens are nearly always found in a contorted position. Pseudoberyx is known by three species from Hakel. They are short-bodied, high, and compressed fishes, with large and pectinated scales. *Diplomystus brevissimus* is another small, elevated fish from Hakel and

Hajula, and it must have swarmed in those waters. Another species of the genus has been described by Cope from the Upper Cretaceous of Brazil; several species, by Leidy and Cope from the Eocene of North America; and another, from the Oligocene of England, by Newton. To-day species are living in the fresh waters of Chili and New South Wales.

The Dercetidæ form an extinct family of elongated fishes, most of whose members lived during the Senonian, but some of which flourished during the Turonian. Two species of Leptotrachelus have been described from Sahel Alma, one from Hakel, and now another is sent to us from Hajula. This is a species very eel-like in form, and has been called *L. serpentinus*. One species of the genus has been described by Cope from the Upper Cretaceous about Yankton, South Dakota, and with it another related form, *Triænaspis virgulatus*.

The Enchodontidæ were numerous during the whole of the Upper Cretaceous. A. S. Woodward regards them as having as their nearest living allies the deep-sea families Odontostomidæ and Aleposauridæ. The enchodonts were undoubtedly predaceous fishes, having long fang-like teeth in their jaws and a huge gape. Five species come from Hakel, four from Hajula, and three from Sahel Alma.

Another interesting family of fishes which have come down the ages to our day from probably the Lower Cretaceous is the Myctophidæ, usually called the Scopelidæ. In our time they are fishes which live in the open sea, many of them being inhabitants of the deep waters, and many possessing phosphorescent organs. Figures and descriptions of many of the living forms may be found in Goode and Bean's *Oceanic Ichthyology*. At Hakel there have been collected eight species; at Hajula, seven, and at Sahel Alma, eight. While most of the species found at Hajula occur also at Hakel, none found at these places have yet been collected at Sahel Alma. Four new species come from Hajula, two of which come likewise from Hakel; and one new and rather small species, *Osmeroides ornatus*, also comes from Hakel. Osmeroides is used here in the sense in which it was originally employed by Agassiz and in place of the latter proposed name, Sardinioides. In the place of Osmeroides, applied to a genus of Elopidæ, the present writer prefers to use the name Holcolepis. How much confusion might have been avoided had the latter name been employed for the elopid genus as soon as it was discovered that *Osmeroides lewesiensis* was not congeneric with *O. monasteri*! Specimens of a Nematonotus of unusually large size and having a greatly elongated first dorsal ray are referred to *N. longispinus* (Davis).

Eels are proverbial for their lubricity, but many of them were caught in the net formed by the sediments of the Senonian ocean. Davis had already in 1887 described from Hakel a little species which he called *Anguilla hakelensis*, but which Woodward refers to his genus Urenchelys. This author has likewise been so fortunate as to find another species of the genus in the Turonian of England. It is the oldest known eel. He describes also a third species from Sahel Alma. The species of the genus are shown to have about one hundred vertebræ and a caudal fin which is distinct from both the dorsal fin and the anal. The present writer has named a fourth species from a specimen collected at Hajula.

Besides these representatives of the family Anguillidæ, the writer has found two species which present most of the characters of Urenchelys, but which are peculiar in possessing well-developed ventral fins, a new feature in eels. This character brings the Apodes into closer relation with the other bony fishes. The species are regarded as forming a new genus, Anguillavus. the type of a new family, Anguillavidæ. One of the species, represented by a complete skeleton six inches long, from Hakel, and a fragment from Hajula, has been named, in honor of a worthy woman, *Anguillavus bathshebæ.* A larger species from Hajula has been christened *A. quadripinnis.* Besides ventral fins, this species seems to have had a row of enlarged scales on each side of the body, perhaps along the lateral line.

Still another eel hails from Hakel. It has been very slender, much elongated, and apparently without a fin of any description; but the feature which most strikes our attention is the structure of the vertebræ. Throughout the length of the body, from the head to the tail, each vertebra resembles, not the ones adjoining it, but the second one behind it or in front of it. This condition appears to be much like that found in the tail of Amia, and the writer explains it in the same way. The species is called *Enchelion montium*, the type of the new family Encheliidæ.

The remaining fishes are regarded as belonging to the order Actinopterygii, or Percomorpha. In these the dorsal and anal fins are usually wholly or partly spinous and the ventral fins are brought forward to beneath the pectorals. The order contains the most highly developed fishes. The Berycidæ, yet represented by some marine and mostly deep-sea forms, appear to have been very abundant during the Upper Cretaceous. A single species is known from Hakel, two from Hajula, and a dozen from Sahel Alma. These data appear to argue that the latter locality is at a higher level than either of the others. A new species of Pycnosterinx, *P. levispinosus*, is described by the author from Hajula. It is a small, compressed species, about an inch and a half in length, deeper than long, and with a steep front.

Three species of the genus Omosoma are referred provisionally by Woodward to the Stromateidæ, a family represented on our Atlantic coast by the butter-fishes and harvest-fishes. The three species are found at Sahel Alma only. Other genera supposed to belong to the same family are described from Westphalia and the south of England.

From Hakel and Hajula there have been obtained three species of Aipichtys, a genus placed by Woodward in the family Carangidæ. One of these species is a new one from Hajula.

The Cretaceous fishes of the families just mentioned, the Berycidæ, the Stromateidæ, and the Carangidæ, with their spiny fins, their thin and often ctenoid scales, their complete vertebræ, their thoroughly ossified skeletons, and their thoracic ventrals, form a strong contrast with the Semionotidæ, the Pycnodontidæ, and even the Chirocentridæ, which formed the greater part of the fish-fauna at the beginning of the Cretaceous period.

It is remarkable that no vertebrates, except fishes, have been found at Mount Lebanon. In the collections examined by the writer, not a scrap of any reptile has been detected. Ichthyosaurs had indeed reached the evening time of their existence. There were doubtless plesiosaurs swimming the deep, and we might expect to find some trace of them in the Mount Lebanon rocks. There were certainly mosasaurs haunting the shores and venturing out on the waves. We should hardly expect to meet with remains of dinosaurs, for these either stalked about on the land or wallowed in the swamps of lakes and rivers. Unless the conditions were peculiar, we might anticipate finding bones of turtles and crocodiles, possibly of pterodactyls.

It appears probable that the deposits of the Mount Lebanon district were laid down in deep water and at a considerable distance from any shores. The fineness of the materials of the rocks favors this view. The large numbers of Myctophidæ and Berycidæ found there, seem to indicate that the depths were considerable. The presence of so many sharks and rays is not opposed to this view, as may be learned by an examination of the lists of fishes in Goode and Bean's *Oceanic Ichthyology*.

In case the deposits were made in deep water and at a considerable distance from land, few reptiles would be entombed in them. Most of these animals probably found it more profitable and more comfortable to remain near the shore.

Dana regarded the Niobrara deposits of Kansas, which have furnished so many fossil fishes, as nearly equivalent to the Turonian of Europe. This was the opinion held by Cope also. A comparison of the Kansas fishes with those of the Turonian and Senonian confirms this opinion. Comparatively few of the genera of Kansas fishes are found in the Senonian of Europe or Syria. On the other hand, about a dozen genera from Kansas are represented in the Old World Turonian.

In 1878 (*Bull U. S. Geol. Surv.*, vol. 4, p. 67), Cope described seven species of fishes which Hayden had collected in what is now South Dakota. No definite statement was made regarding the locality; but, written on the blocks of soft limestone bearing the types, the present writer has found the word "Yankton." This no doubt indicates approximately the locality whence the fishes were derived. Of these fishes, two species belong to Leptotrachelus and one to Triæaspis, a genus close to Leptotrachelus. Of other known species of the latter genus, all are found in the Senonian, although one occurs in the Turonian also. One species from Yankton belongs to Spaniodon. The other three species of the genus are from Sahel Alma. Three of the species from Yankton belong to Leptosomus. Two other species of Leptosomus are known from Westphalia and two from Mount Lebanon. Cope supposed that these fishes were obtained in the Niobrara deposits; but, judging from their close relationships with Mount Lebanon forms, it appears highly probable that they came from a higher horizon, probably the Pierre. It is a matter of considerable importance that some geologist in that region should explore these beds. There appear to be great numbers of the fishes, since on one block about six inches square there are three of Cope's types and one on the opposite side. The reader will find a figure of this block on Plate 5, of volume 19 of the *Bulletin of the American Museum of Natural History.*

AMERICAN MUSEUM OF NATURAL HISTORY.
New York, May 30, 1903.